Rejection Under § 103(a) Based on JP '724

The Examiner argues that JP '724 teaches an alloy type thermal fuse comprising a thermal fuse element having an alloy composition containing 40 to 46 weight % Sn, 7 to 12 weight % Bi, 0.5 to 3.5 weight % Ag, and remainder In. The Examiner argues that JP '724 does not require the addition of any element whose use is prohibited due to its harmful effects on a living body, and that the amounts of Bi, Ag and In allegedly overlap with the claimed ranges. Therefore, the Examiner contends that it would have been obvious to one having ordinary skill in the art to select the desired amounts of Bi, Ag, and In from the JP '724 ranges because JP '724 teaches the same utility as the presently claimed invention.

Regarding the Sn range recited in claims 3-4, the Examiner argues that due to the closeness of the range disclosed by JP '724 (40 to 46%) to the claimed range (greater than 46% to 70%), one skilled in the art would have expected an amount of Sn of slightly greater than 46 weight % to provide the same properties to an alloy as 46 weight %. The Examiner takes the position that the alloy of JP '724 would have inevitable impurities. Regarding claims 7-10, the Examiner argues that JP '724 teaches connecting the fuse element between lead conductors, and that at least a portion of each of the lead conductors is bonded to a fuse element and is covered with a silver paste (i.e. film). Accordingly, the Examiner concludes that the claims are obvious over JP '724. Applicants respectfully traverse this rejection as follows.

As previously explained on the record, the presently claimed invention is directed to an alloy type thermal fuse which uses a particular ternary allow composition as the material for the fuse element. This alloy composition contains more than 46 to 70% Sn, 18 to less than 48% In, and 1 to less than 12% Bi, and does not contain any elements whose use is prohibited due to harmful effects on living bodies. The thermal fuses according to the presently claimed invention thus achieve the goal of environmental conservation by protecting both individuals involved in the manufacturing of the thermal fuses and the end-users who handle them.

Comparison of Claimed and Cited Prior Art Alloys

	Percentage Sn	Percentage In	Percentage Bi
presently claimed alloy	**> 46 to 70**	**18 to < 48**	**1 to < 12**
JP '724	40 to 46	42 to 53	7 to 12

Alloy type thermal fuses and fuse elements having the claimed elemental compositions were developed by Applicant as a result of intensive study in order to provide a fuse having a narrow operating temperature range and excellent overload and dielectric breakdown characteristics.

The Examiner argues that the claimed ranges are overlapping or close to the ranges taught by JP '724. Although the ranges *per se* of two of the elemental components (In and Bi) indeed overlap or touch the prior art ranges, the overall alloy compositions do not overlap, as demonstrated in the liquidus projection diagram attached hereto as Appendix 1.

A liquidus projection diagram is a graphical representation of the elemental composition of a ternary alloy which portrays the concentrations of all three components at one time. Since the concentrations of all three components are critical, it is easier and more accurate to compare the liquidus projection diagrams than the numerical ranges individually. Thus, a liquidus projection diagram (which graphically represents the claimed composition) is a proper way to demonstrate that the claimed and prior art compositions as a whole do not overlap.

In a ternary alloy, the concentrations of <u>all</u> of the components are critical. In this case, the concentration of the third elemental component (Sn), which does not overlap with that of JP '724, results in an overall composition which does not overlap with the presently claimed alloy. <u>Thus, since the overall compositions themselves do not overlap, the claimed and prior art alloys would not have been expected to have the same properties and the Examiner's unsubstantiated assertion to the contrary is incorrect</u>.

Additionally, the Examiner has not demonstrated, why, based on JP '724, one would have been motivated to modify the elemental concentrations (and in particular the concentration of Sn) to arrive at the present invention.

According to MPEP 2142, there must be some suggestion or motivation, either in the reference itself or in the knowledge generally available to one of ordinary skill in the art, to modify the reference, a reasonable expectation of success, and the prior art reference must teach or suggest all of the claim limitations. The teaching or suggestion to make the modification and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. No such teaching or suggestion is found in JP '724 as follows.

In order to arrive at the claimed Sn concentration from that recited in JP '724, one skilled in the art would have had to, while routinely experimenting with the JP '724 alloy, increase the

concentration of Sn from the JP '724 range of 40-46% to the claimed range of greater than 46% to 70%. This increase would have necessitated a reduction in the concentration of at least one of the other elements, such as to 6% Bi, 47% In or to 12% Bi, 41% In (below the recited ranges of Bi and In, respectively). However, while the broad alloy of JP '724 contains 40-46% Sn, the preferred Sn concentration is 44.5% (paragraph [0012] of JP '724), which is in the middle of the JP '724 range. Similarly, the In concentrations taught by JP '724 is 48.1%, which is also in the middle of the JP '724 range. There is no suggestion in JP '724 that the alloy should be modified to increase the Sn concentration to > 46 to 70% (above the recited range) and thus decrease the Bi or Sn concentration to below the recite range and away from the preferred concentrations. Since the Examiner has not showed a motivation to vary the prior art concentrations in order to arrive at the claimed concentrations, the Examiner has not established a *prima facie* case of obviousness.

The MPEP states that differences in concentrations will not support the patentability of subject matter encompassed by the prior art unless there is evidence that concentrations or temperature is critical. In the present case, the concentration of the component elements are indeed critical to the resulting alloy. As previously explained on the record, it is taught in the Background Section of the present application that in fuse elements having alloy compositions with a solid-liquid coexisting region (between the solidus and liquidus temperatures), there is a possibility that the fuse element will be fused off at an uncertain temperature in this region. A wide coexistence region thus results in a wide operating temperature range of the fuse. Conventionally, in order to reduce this dispersion of operating temperature, an alloy having a narrow solid-liquid coexistence region, and ideally a eutectic composition, is utilized so that the fuse element fuses off at approximately the liquidus temperature (which is equal to the solidus temperature in a eutectic composition).

A variety of ternary Sn, In, Bi alloys are known. As shown in the liquid phase surface diagram in Appendix 1, these alloys have a binary eutectic point at 52In-48Sn (point E1) and a ternary eutectic point (point E2) at 21Sn-48In-31Bi. The binary eutectic curve which elongates from the binary eutectic point toward the ternary eutectic point passes through a region having 24-47% Sn, 50-47% In, and 0-28% Bi. Alloy compositions in regions separated from the binary eutectic curve have wider solid-liquid coexistence regions, which may possibly widen an indefinite region of temperatures at which the fuse element fuses off and also increase the

dispersion of the operating temperature of the thermal fuse. Accordingly, this region has not traditionally been investigated for suppressing the dispersion of operating temperature range by narrowing the solid-liquid coexistence region.

However, by studying a variety of Bi-Sn-In alloys having different compositions and measuring the DSC (differential scanning calorimetry) profiles thereof, Applicant has surprisingly found that when an alloy composition in a specific region which is separated from the binary eutectic curve is used as a fuse element, the resulting fuse element can be concentrically fused off in the vicinity of the maximum endothermic peak, and excellent overload and dielectric breakdown characteristics are thus obtained. Applicant has thus discovered a specific ternary In-Sn-Bi alloy composition, usable for a fuse element, which is suitable for environmental conservation and which provides excellent overload and dielectric breakdown characteristics and a narrow operating temperature range.

The alloy composition in this region, which is separated from the binary eutectic curve, has a wide liquid coexistence region and a single maximum endothermic peak. Accordingly, the dispersion of the operating temperature of the alloy thermal fuse may be controlled. Moreover, in the alloy composition, the total amount of In and Sn, which have a relatively smaller surface tension, is larger than the amount of Bi, which has a larger surface tension. Therefore, the wettability of the solid-liquid coexisting at the maximum endothermic peak is sufficiently improved even before the completion of liquidification, so that spheroid diversion of the thermal fuse element can be performed in the vicinity of the maximum endothermic peak. Consequently, the dispersion of the operating temperature of the thermal fuse can be reduced (and set to be within a range of ± 5° C). The holding temperature of such thermal fuses (20 °C less than the operating temperature) may be less than or equal to the solidus temperature, which is desirable. Further, due to the relatively large percentages of In and Sn in the alloys, fuse elements having sufficient ductility to draw into thin wires, such as 200 to 300 μmφ, can be achieved.

Applicant has further found favorable results from utilization of a fuse element having the claimed alloy composition which is in a range having a wide solid-liquid coexistence region and is separated from the peripheral region of the binary eutectic curve whose solid-liquid coexistence region is narrow. Specifically, using such an alloy avoids problems resulting from a narrow solid-liquid coexistence region. Namely, the alloy during energizing and temperature rise is instantly changed from solid to liquid, which causes an arc to be generated easily during

operation. The resulting local and sudden temperature rise causes vaporization of the flux and raises the internal pressure or chars the flux. In addition, the molten alloy or the charred flux is intensely scattered. Due to these occurrences, physical destruction, such as crack generation due to local and sudden internal pressure rise, or reconduction between charred flux portions, easily occurs during operation. Insulation distance is thus shortened and dielectric breakdown results. The wide solid-liquid coexistence region which is exhibited by the present invention will eliminate these undesirable characteristics.

The JP '724 alloy composition is set to include the binary eutectic curve, making the solid-liquid coexistence region narrow and suppressing dispersion of the operating temperature. However, such a prior art alloy cannot avoid the problems which inevitably occur when the solid-liquid coexistence region is narrow, such as the physical destruction described above. In contrast, the presently claimed alloy defines a region which is separated from the binary eutectic curve. In the presently claimed alloy composition, the solid-liquid coexistence region is wide and a single maximum endothermic peak is exhibited. The wide solid-liquid coexistence region overcomes a problem caused by a narrow solid-liquid coexistence region, i.e, physical destruction during operation of a fuse, deterioration of insulation resistance, and dielectric breakdown after an operation of a fuse. It is possible to reduce the dispersion of operation temperature of a fuse owing to the single maximum endothermic peak.

Therefore, despite the fact that the Bi and In concentrations in the claimed alloy composition overlap with that taught by JP '724, the ternary alloy compositions are in fact dramatically different in properties due in part to the overlap of the JP '724 alloy with the binary eutectic curve and the separation of the claimed alloy composition from this curve. An alloy composition, such as that taught by JP '724, which falls on the binary eutectic curve, does not exhibit the unexpected properties of the claimed alloy fuses: a narrow operating temperature range and excellent overload and dielectric breakdown characteristics. Accordingly, the concentrations of the alloy components are indeed critical to the present invention, and the presently claimed invention would not have been obvious to one skilled in the art based on JP '724. Reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under 35 U.S.C. § 103(a) Based on JP '724 in view of JP '732

Regarding claims 11-18, the Examiner argues that JP '724 teaches that lead conductors are bonded to ends of the fuse element, respectively, a flux is applied to the fuse element, the flux-applied fuse element is passed through a ceramic tube and gas between ends of the ceramic tubing and the lead conductors are sealingly closed. The Examiner acknowledges that JP '724 does not teach that the ends of the lead conductors have a disk-like shape, and ends of the fuse element are bonded to front faces of the disks.

However, JP '732 allegedly teaches providing lead conductors with a disk-like shape at the ends of the lead conductors and bonding the fuse elements to the front faces of the disks in order to prevent flux from adhering to the ends of the cylindrical case and to achieve quick separation when the fuse is activated. Therefore, the Examiner takes the position that it would have been obvious to one of ordinary skill in the art to modify the method of JP '724 by providing lead conductors with a disk-like shape at the ends of the lead conductors and bonding the fuse elements to the front faces of the disks in order to prevent flux from adhering to the ends of the cylindrical case and to achieve quick separation when the fuse is activated as taught by JP '732. Applicants respectfully traverse this rejection as follows.

As previously explained, the effects of the presently claimed invention would not have been obvious based on JP '724, and even the proposed combination with JP '732 would not cure this deficiency. JP '732 does not teach any Sn/In/Bi alloys, and thus certainly would not provide the motivation to modify the JP '724 alloy to arrive at the presently claimed invention. Accordingly, the presently claimed invention would not have been obvious based on the proposed combination of JP '724 and JP '732, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Rejection Under 35 U.S.C. § 103(a) Based on JP '724, JP '732, and GB '608

Regarding claims 23-28, the Examiner acknowledges that the proposed combination of JP '724 and JP '732 does not teach or suggest providing a heating element for fusing off the fuse element. However, GB '608 allegedly teaches providing a resistor to blow a thermal fuse in order to terminate heating in a heating circuit for an electric blanket. Therefore, the Examiner takes the position that it would have been obvious to modify the JP '724/JP '732 combination by

providing a resistor to blow a thermal fuse in order to terminate heating in a heating circuit for an electric blanket, as taught by GB '608. Applicants respectfully traverse this rejection as follows.

As previously explained, the effects of the presently claimed invention would not have been obvious based on the proposed combination of JP '724 and JP '732, and even the proposed combination with GB '608 would not cure this deficiency. GB '608 does not teach any Sn/In/Bi alloys, and thus certainly would not provide the motivation to modify the JP '724/JP '732 alloy to arrive at the presently claimed invention. Accordingly, the presently claimed invention would not have been obvious based on the proposed combination of JP '724, JP '732, and GB '608, and reconsideration and withdrawal of the § 103(a) rejection are respectfully requested.

Double Patenting Rejection

The Examiner has provisionally rejected claims 3-18 and 23-38 on the ground of obviousness-type double patenting as being unpatentable over claims 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 33, 35, 45, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81 and 83 of co-pending application no. 10/656,561. The Examiner argues that the present and prior claims are not patentably distinct from each other because the co-pending application teaches an alloy type thermal fuse comprising a thermal fuse element having an alloy composition containing 25 to 60% weight % Sn, 12 to 33 weight % Bi, 20 to 50 weight % In, and 0.1 to 3.5 weight % Ag. The Examiner also argues that the amounts of Sn, In, and Ag overlap with the claimed ranges. The Examiner argues that the claimed amount of Bi (1 to 12%) is close to the prior art range (larger than 12 to 44%) and that it would have been obvious to select an amount of Bi of 12 weight percent because one would have expected such an amount to yield the same properties as an alloy having slightly greater than 12 weight % Bi.

While not agreeing with the Examiner's conclusions, Applicant files herewith a Terminal Disclaimer and Statement of Common Ownership with respect to the '561 application. Accordingly, withdrawal of the double patenting rejection is respectfully requested.

In view of preceding Remarks and Terminal Disclaimer, it is respectfully submitted that the present claims are patentably distinct from the prior art of record and in condition for allowance. A Notice of Allowance is respectfully requested.

Respectfully submitted,

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December 21, 2006 By: Sandra M Katz
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Enclosure: Terminal Disclaimer and Statement of Common Ownership; Appendix 1